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ABSTRACT

The use of computers in education and general society is continually expanding, but the growing need for highly educated computer technologists will continue unless universities take major steps toward the reallocation of their resources in favor of the burgeoning computer science departments, and government and industry provide a significant increase in graduate fellowships and other types of graduate student support. Computer training in the high schools may soon become available to the extent that clerks are prepared to become effective transaction terminal and data entry operators. However, few high schools can or should provide sufficient training for entry-level personnel in the computer center for operations, programming, or systems analysis, which should be provided by postsecondary institutions. (Author/CMV)

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COMPUTER LITERACY AND SOCIETAL IMPACT OF COMPUTERS: EDUCATION AND MANPOWER

by

John W. Hamblen

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Computer Literacy and Societal Impact of Computers: Education and Manpower

by

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Computer Literacy:

The use of computers in education is continually expanding. The advent of the mini-computers a few years ago started the expansion and now the availability of the various micro-computers will cause the expansion to boom in an exponential manner. In ten years every elementary and secondary school that considers itself up to date will have one or more micro-computers just as they now have various pieces of audio-visual equipment and science laboratories. The computer literacy problem should almost vanish at the college entry level by the end of this century (see Table I) [1,2]. The high schools will need such courses for some time afterwards and perhaps indefinitely. In a sampling survey carried out jointly by AFIPS and TIME in 1971 [3] it was estimated that 49% of the population had at some time had a job which required either direct or indirect contact with a computer. I expect that this percentage is substantially higher now perhaps as high as 70-80%. The addition of the numerous transaction terminals in department stores, banks, discount stores and supermarkets alone make up a major portion of this projected increase.

ESTIMATED NUMBERS OF COLLEGES AND UNIVERSITIES OFFERING "COMPUTER APPRECIATION" COURSES WITH ENROLLMENT

	1969-70	1976-77	1995(Proj.)
No. Institutions	277	546	100
Enrollment	24,100	56,400	10,000

Table I

Computer Manpower - The Role of the Secondary Schools:

Computer training in the high schools may soon become available to the extent that clerks are prepared to become effective transaction terminal and data entry operators. However, I do not believe that many high schools can or should provide sufficient training for entry-level personnel in the computer center for operations, programming or systems analysis. This will be the role of the post-secondary institutions indefinitely.

The high schools will become more and more involved in the teaching of computer languages and such courses in colleges and universities will become remedial toward the end of this century. (see Table II) Nevertheless, as I stated above, I do not see many high school graduates becoming entry level candidates for the Computer Manpower Pool, even if they have studied one or more computer languages in the high school.

ESTIMATED NUMBERS OF COURSES AND ENROLLMENTS IN "INTRODUCTORY COURSES IN SOME COMPUTER LANGUAGE SUCH AS FORTRAN, PL/1, BASIC, ALGOL"

	1969-70	1976-77	1995 (Proj.)
Courses (Institutions)	1,565	2,425	1,000
Enrollment	176,200	277,200	150,000

Table II

Computer Manpower Pool: Demand

In references (4) and (5) I present a model which I developed for estimating the annual needs for computer manpower in the United States by job classification and desired educational level. The results are given in Tables III and IV, and Figure 1. In these references (and elsewhere) I have stated that I believe that "The cause of many of the problems associated with computer usage is the overutilization of undereducated people." [2] This situation exists not by choice but by circumstance. A sufficient

number of properly educated people are not available, nor will we be anyway near to meeting the demand (Table IV) in the foreseeable future.

IF TRAINED MANPOWER BECOMES AVAILABLE
HOW MANY POSITIONS IN EACH
CLASSIFICATION WOULD
BE REFILLED BY
POSTSECONDARY VOCATIONAL
OR COLLEGE TRAINED
PERSONNEL?

Mgt.	All	105,000
Analysts	All	175,000
Systems Prog.	All	105,000
Appl. Prog.	All	245,000
Operators	All	210,000
Other Oper.	20%	112,000
	Total	952,000
	Teachers	5,200
	Total Positions	957,000

Table III

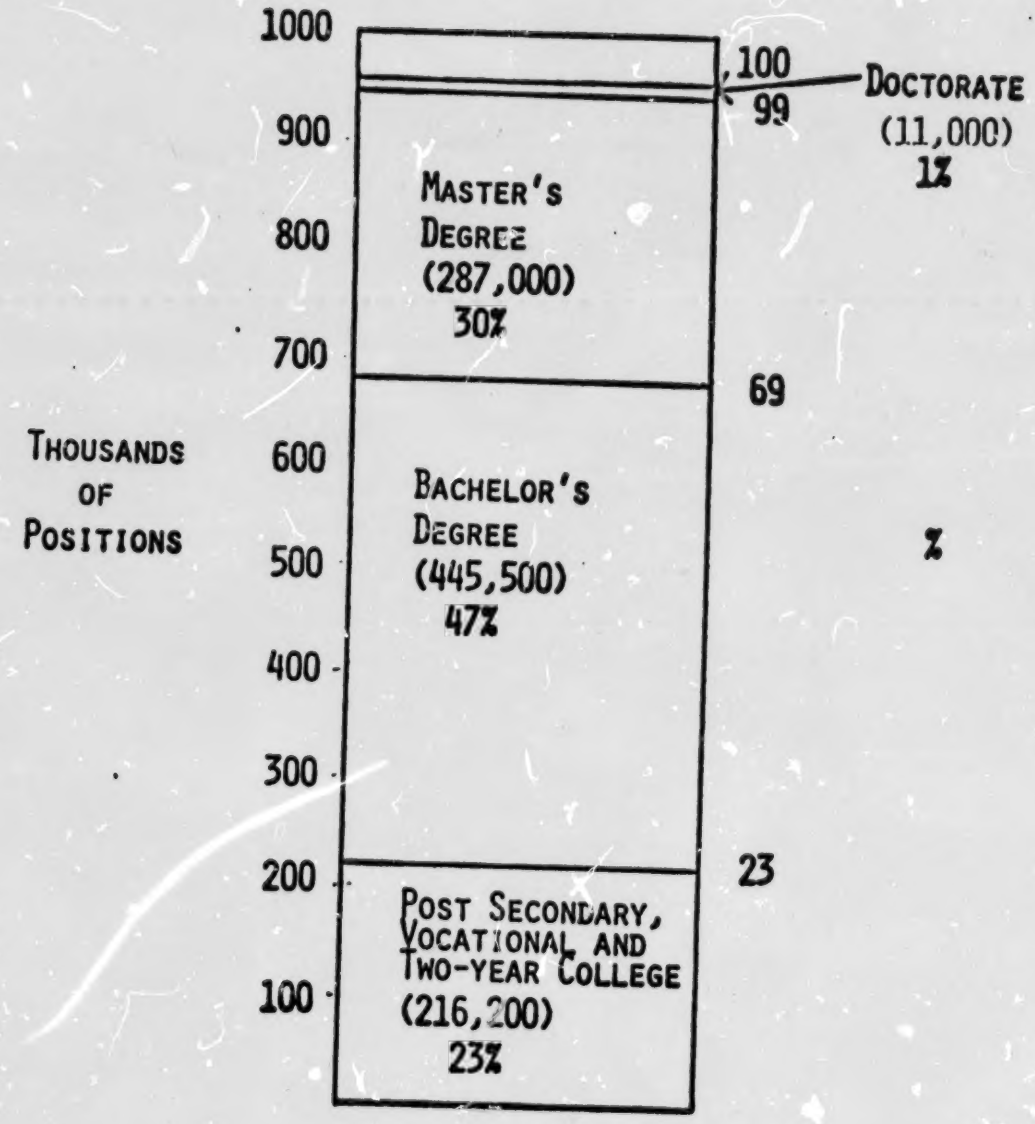
ESTIMATED
ANNUAL NEW COMPUTER
MANPOWER NEEDS

EDUCATION LEVEL

P-S Voc. 2-yr.	4-yr.	M.S.	Doct.	Total
26,376	55,571	34,153	1,012	117,112

Table IV

DISTRIBUTION OF EXPECTED TRAINING FOR REPLACEMENTS



BASED UPON 1973 MODEL

Figure 1

Computer Manpower Pool: Supply

Table V does offer some encouragement in revealing that the undergraduate enrollment for computer related majors doubled from academic year 1973-74 to 1976-77. On the other hand Table VI shows that the numbers of graduate majors showed a slackening in the growth rate for the same period. The lower increase in the numbers of graduate majors is largely due to two limiting and competing factors. One is that we have reached saturation in the numbers that we can support through university source and grant supported assistantships and we have had relatively little -- as measured against relative need -- fellowship support from government agencies such as the National Science Foundation and industry. If there existed a corresponding need in fields such as Chemistry, Physics or Mathematics we would see an immediate response from NSF and others with increased numbers of fellowships, etc. As a relatively new discipline we simply do not have the representation in these agencies nor alumni in industry to allow us to compete with the more established disciplines.

THE NUMBERS OF UNDERGRADUATE MAJORS HAD
BEEN INCREASING AT THE RATE OF NEARLY 15,000
PER YEAR THRU 1970

1964-65	4,338
1966-67	22,161
1969-70	65,916
1973-74	52,597*
1976-77	105,200

*Drop due to decrease in number of two-year programs in data processing.

Table V

THE NUMBERS OF GRADUATE MAJORS
HAVE BEEN INCREASING AT THE RATE
OF ABOUT 750 PER YEAR
SINCE 1970

1964-65	1,315
1966-67	4,936
1969-70	9,123
1973-74	12,116
1976-77	14,343

Table VI

Table VII reveals that we have had a resurgence in the two year programs which had previously dropped from a peak around 1972. I was somewhat surprised to see this, in particular, the degree of the comeback. Although I have not obtained recent data from the USOE on other post-secondary but less than two year programs, I would expect a possible decrease in these programs and their graduates. Again I caution the faculty of two year programs to remain in close contact with nearby four year programs and cater to the transfer student. At the University of Missouri - Rolla we have a very good relationship with the community colleges in the St. Louis and Kansas City areas and obtain 25-35 transfers each year from these colleges. The transfer process is enhanced by an equivalency table linking their courses to ours. It is further enhanced by our assigning the same faculty member as transfer advisor (Professor F. G. Walters) year after year.

ESTIMATED NUMBER OF TWO-YEAR DEGREE PROGRAMS
AND NUMBER OF DEGREES AWARDED

	1966-67	1969-70	1973-74	1976-77
No. Programs	178	405	338	570
No. Degrees Awarded	1281	6051	4831	8271

Table VII

Although the increases in both the numbers of four-year programs and their graduates were also substantial (see Table VIII) only the number of programs (541) exceeded my expectations in a surprising amount [2].

ESTIMATED NUMBERS OF BACHELOR'S DEGREE PROGRAMS AND DEGREES AWARDED

	1966-67	1969-70	1973-74	1976-77
No. Programs	90	198	302	541
No. Degrees	594	2208	5951	9509

Table VIII

At the master's level (see Table IX) the increase in the number of degrees awarded was somewhat less than my expectations [2]. Furthermore the number of Doctorate degrees awarded during 1976-77 was substantially lower than I had projected [2].

ESTIMATED NUMBERS OF MASTER'S PROGRAMS AND DEGREES AWARDED

	1966-67	1969-70	1973-74	1976-77
No. Programs	98	155	157	224
No. Degrees	742	1442	2854	3161

Table IX

Figures 2 and 3 depict graphically the data presented in Tables VII - X. Figure 4 shows the deficits in the supply of computer manpower very dramatically. The gaps between supply and demand at the Bachelor's and Master's levels are shocking to say the least, and at the Doctorate level very discouraging to the department chairpersons who have the responsibility for recruiting faculty. This extreme shortage is probably a major contributing factor to the fact that at present there are now or pending an

ESTIMATES OF THE NUMBERS OF DEGREE PROGRAMS
IN COMPUTER SCIENCE, DATA PROCESSING, ETC.

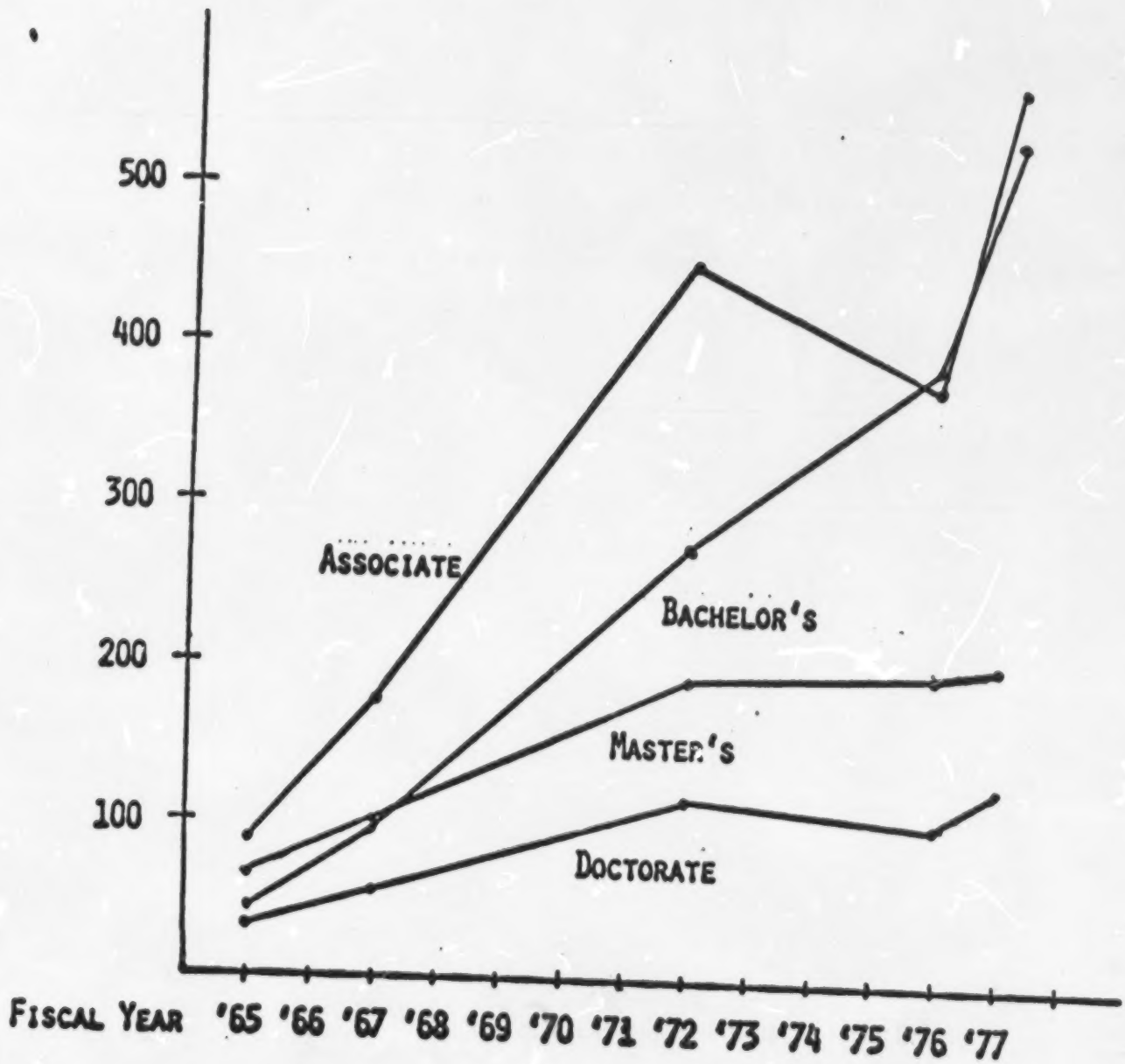


Figure 2

ESTIMATED NUMBERS OF DEGREES AWARDED
IN COMPUTER SCIENCE, DATA PROCESSING, ETC.

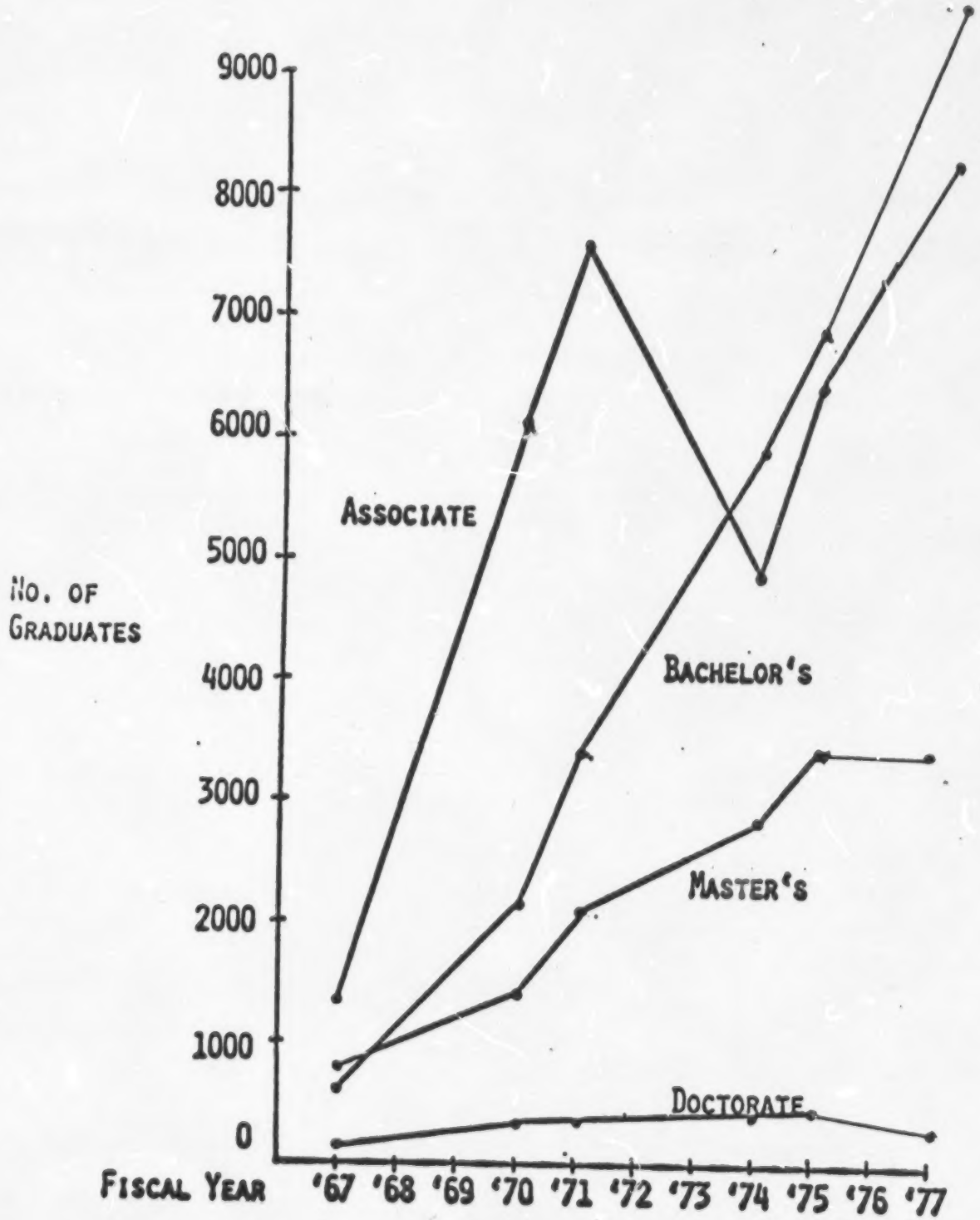


Figure 3

ESTIMATED NEW COMPUTER MANPOWER PRODUCTION FOR 1977 VS NEEDS

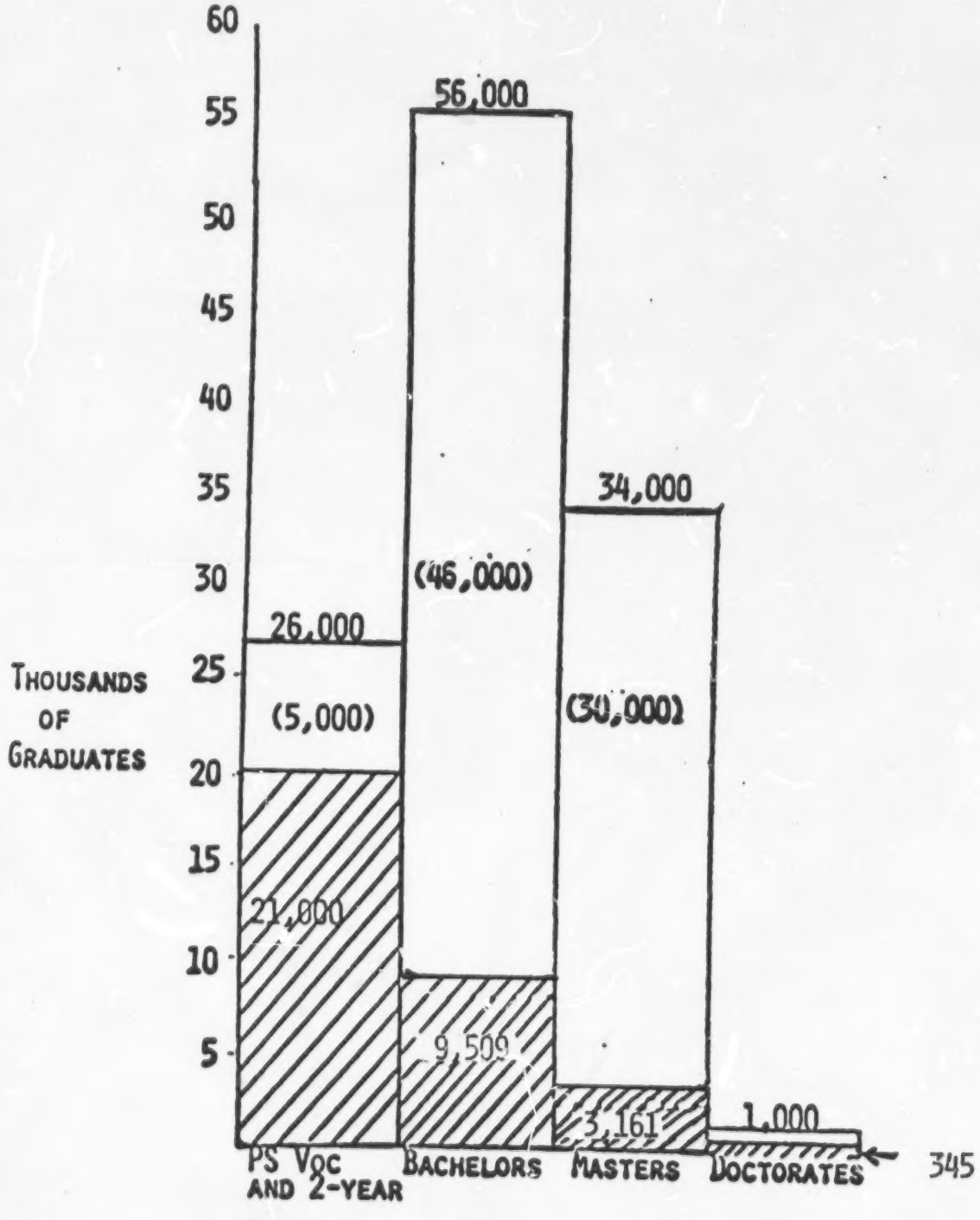


Figure 4

estimated fifteen vacancies in chairs of Ph.D. granting Computer (and Information) Science departments.

ESTIMATED NUMBERS OF PH.D. PROGRAMS
AND DEGREES AWARDED

	1966-67	1969-70	1973-74	1976-77
No. Programs*	58	98	90	119
No. Degrees	174	307	369	345

*Includes options in Math, Electrical Engineering, etc.

Table X

Tables XI and XII provide further dramatic evidence of the shortages and high demands.

Unless the universities take major steps toward the re-allocation of their resources in favor of the burgeoning computer science departments and the NSF and industry provide a significant increase in graduate fellowships and other types of graduate student support the present situation will only worsen for the next several years. In the meantime Ph.D.'s in Mathematics, Physics and Chemistry will continue to get M.S. degrees in Computer Science to enhance their employment potential.

Acknowledgments

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EMPLOYMENT REGISTER -- COMPUTER SCIENCE CONFERENCE
Detroit, Michigan
February 20-24, 1978

Openings Listed	3000
Applicants	300

Table XI

CURRENT (FEB. 1978) OPENINGS WITH BELL LABS
FOR COMPUTER SCIENCE GRADUATES
(RE: Dr. M. Irvine, Computer Science Conference)

	Bachelors	Masters	Ph.D.
Software Types	110	140	60
Hardware Types	40	20	25
Total	150	160	85

Table XII

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